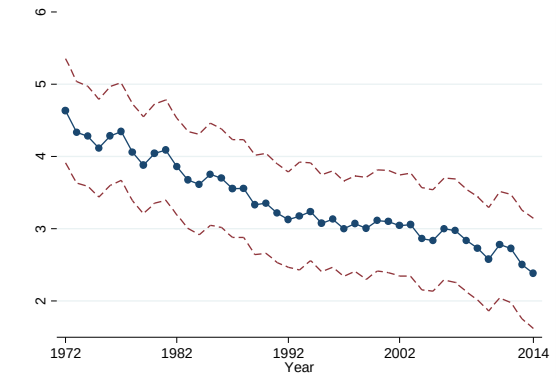
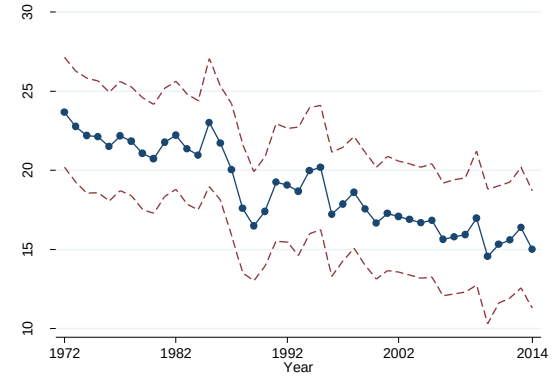
Online Appendix A:
Appendix Figure and Table

Appendix Figure 1
U.S. Surface Water Pollution Trends, 1972-2014, Additional Pollutants

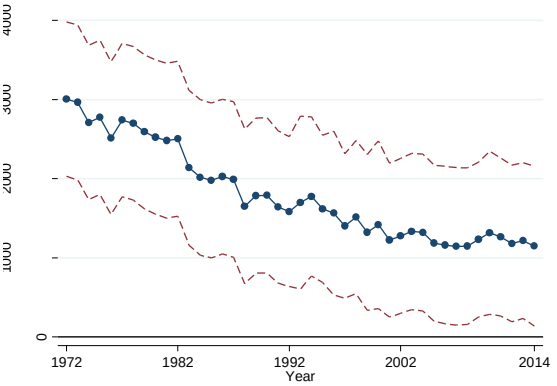
Panel A. Biochemical Oxygen Demand



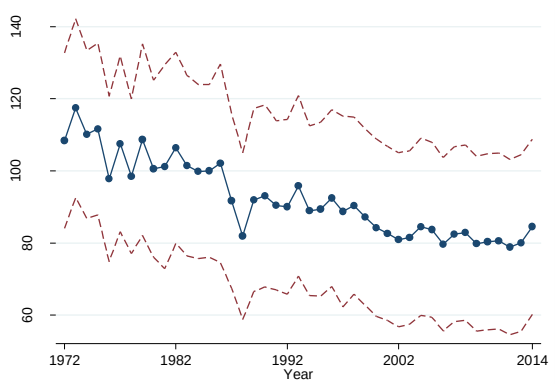
Panel B. Dissolved Oxygen Saturation Deficit



Panel C. Fecal Coliforms



Panel D. Total Suspended Solids



Note: see notes to Figure 2.

Appendix Table 1

Prevalence of Economic Research on Air versus Water Pollution

	Type of Pollution			Ratio: Air v. Water	
	Air	Surface Water	Drinking Water	Air/ Surface	Air/ Drinking
	(1)	(2)	(3)	(4)	(5)
Economics journal articles					
All	4,731	4,449	3,335	1.1	1.4
Year 2000+	2,258	1,944	1,718	1.2	1.3
Top 5 journals	236	146	48	1.6	4.9
Environmental/energy economics	839	729	138	1.2	6.1
Agricultural economics	359	831	177	0.4	2.0
Non-economics journal articles					
Environment	7,595	14,539	10,444	0.5	0.7
Health	8,961	6,118	10,818	1.5	0.8
Presentations					
NBER Summer Institute	49	13	3	3.8	3.1
ASSA Meetings (AERE sessions)	93	44	17	2.1	2.6
Environmental Economics Textbooks # Pages					
Mean	35	15	6	2.3	1.7
Median	30	9	2	3.3	2.7
Public finance textbooks Mean # Pages	4.5	0	0	—	—

Note: All journal articles are from JSTOR. Environmental textbooks include Chapman (2000), Goodstein (2002), Berck and Helfand (2011), Kolstad (2011), Callan and Thomas (2013), Anderson and Libecap (2014), Freeman, Herriges, and Kling (2014), Phaneuf and Requate (2017), and Tietenberg and Lewis (2018). Public finance textbooks include Rosen (2002) and Gruber (2011). The NBER data cover 2009-2018 environmental/energy economics sessions, while the ASSA data cover years 2011-2019. The ASSA papers include all those in sessions contributed by the Association of Environmental and Resource Economists (AERE). See Appendix C for additional details.

Online Appendix B:
Estimates of Spending on Air and Water Pollution Control Programs

This appendix describes available data on the total costs of investments in surface water quality, drinking water, and air pollution abatement. We construct estimates of spending using a number of sources. These include Keiser and Shapiro's (2019) analysis of the Clean Water Act municipal grants program, Keiser, Kling, and Shapiro's (2019) analysis of benefits and costs of surface water quality programs, a Congressional Research Service report on federal appropriations of surface and drinking water programs at USEPA (Copeland 2015), a Congressional Budget Office (2018) report on public spending on transportation and water infrastructure, and a report on local spending on water and wastewater services from the U.S. Conference of Mayors (2010). We also use a number of reports by USEPA detailing costs of the Clean Air Act and Keiser and Shapiro's (2019) analysis of spending on air pollution control programs. Obtaining comprehensive spending estimates in each of these areas faces a number of challenges including incomplete reporting across communities and across time and the potential for double counting of federal, state, and local spending.

This Appendix reports a range of estimates; the main text highlights the best available estimates. We also focus on the period 1970 to 2014 since spending estimates for each of these categories are more complete for this period. We deflate all estimates to $2017 using the Engineering News-Record Construction Cost Index.

Surface Water Quality – Preferred Estimate: $2.8 trillion (range of $1.9 to $3.0 trillion)

Keiser and Shapiro (2019) and Keiser, Kling, and Shapiro (2019) report estimates of spending on surface water quality pollution control programs that are driven primarily by federal policies (i.e, the Clean Water Act's municipal grants program and the Clean Water Act's State Revolving Funds program), industrial spending on water pollution abatement, and non-point source programs sponsored by the federal government such as a number of U.S. Department of Agriculture conservation programs.

Federal Spending – Preferred Estimate: $0.6 trillion (range of $0.5 to $0.6 trillion)

To account for federal government funds, we use Keiser and Shapiro's (2019) estimate of spending on grants to local municipalities and net out local matching expenditures on capital, operations, and maintenance costs. We add spending estimates on the federal portion of Clean Water State Revolving Funds (CWSRFs) from Keiser, Kling, and Shapiro (2019). These sources suggest approximately $370 billion in direct federal spending on wastewater treatment. This estimate exceeds Copeland's (2015) estimate of $256 billion in total appropriations for wastewater treatment programs, though Copeland's estimates start in 1973. This estimate also exceeds CBO's (2018) estimate of total federal spending on both wastewater and drinking water treatment ($363 billion). However, Copeland's federal appropriation estimates for drinking water only total $26 billion, which suggests CBO's total estimate is likely largely due to wastewater treatment. Each source suggests similar patterns in funding over time, with much greater amounts in the 1970s. We use the estimates from Keiser and Shapiro (2019) as they reflect estimates of grant spending recovered from USEPA records and Clean Water State Revolving Funds estimates from USEPA.

In addition to these funds, we include spending on non-point source control programs from Keiser, Kling, and Shapiro (2019) that primarily reflect spending on USDA conservation programs. This adds an additional $219 billion. Our preferred estimates for total federal spending on wastewater treatment is thus $589 billion with a range of $475 billion to $589 billion.

Local Spending - Preferred Estimate: $1.6 trillion (range of $0.8 to 1.7 trillion)

Our estimates of local spending on wastewater treatment comes from CBO (2018) and the U.S. Conference of Mayors (2010). We first take annual spending estimates from CBO (2018) that represent state and local spending for infrastructure, net of federal grant and loan subsidies. These estimates represent both wastewater and drinking water spending. To apportion this spending between wastewater and drinking water, we use the U.S. Conference of Mayors (2010) report that provides estimates of the share of local spending by decade between wastewater and drinking water treatment. The CBO (2018) and U.S. Conference of Mayors (2010) estimates of total spending on wastewater and drinking water treatment track each other closely and are based on similar census data. However, the U.S. Conference of Mayors local spending estimates may also reflect federal grants and subsidies. For example, CBO's estimates of federal contributions to wastewater and drinking water total $363 billion. This figure added to CBO's estimate of $3.6 trillion in state and local spending net of federal spending closely approximates the U.S. Conference of Mayors (2010) estimate ($3.92 vs. $3.87 trillion).

Keiser, Kling, and Shapiro (2019) present estimates of local spending tied to federal and state programs (i.e., the Clean Water Act grants and CWSRF). These estimates are broadly similar through 1986 ($251 billion for Keiser, Kling, and Shapiro vs. $348 billion for CBO and the Conference of Mayor estimates). The main divergences occur after 1986, corresponding to a sharp decline in the federal grants program. Since Keiser, Kling, and Shapiro focus on spending tied to federal programs while CBO includes local spending independent of federal grants, the CBO estimate is likely to be more complete.

Our preferred estimate of local spending is thus $1.6 trillion with a range of $801 billion to $1.7 trillion. The Keiser and Shapiro (2019) local estimate reflects our lower bound and the U.S. Conference of Mayors (2010) report reflects our upper bound.

Industrial - Preferred Estimate: $0.6 trillion

Our estimates of industrial spending are based on Keiser and Shapiro (2019) and Keiser, Kling, and Shapiro (2019). These estimates are based on Pollution Abatement Costs and Expenditures (PACE) surveys from 1973 – 1986, 1988 – 1994, and 2005.

Drinking Water Quality – Preferred Estimate: $2.0 trillion (range of $2.0 to $2.2 trillion)

Federal Spending - Preferred Estimate: $26B

We use Copeland's (2015) estimate of federal appropriations for Drinking Water State Revolving Funds, which started in 1997. These total $26B.

Local and State Spending - Preferred Estimate: $1.9 trillion (range of $1.9 to $2.1 trillion)

To estimate local and state spending, we follow a similar protocol for drinking water as for wastewater. We allocate CBO's (2018) estimate of total local spending net of federal contributions based on the U.S. Conference of Mayors (2010) estimate of the share of spending assigned to wastewater versus drinking water. This yields an estimate of $1.9 trillion in local and state spending on drinking water treatment. The U.S. Conference of Mayors (2010) estimates provide a slightly larger figure at $2.1 trillion.

Air Pollution Control – Preferred Estimate: $2.1 trillion (range of $2.1 to 2.7 trillion)

We use EPA's (1997) retrospective analysis of the Clean Air Act as the main source for expenditures on air pollution control. These expenditures represent additional spending due to the Clean Air Act. We do not observe expenditures from before the Clean Air Act, so these estimates may provide a lower bound on total spending. EPA (1997) estimates annual expenditures on compliance costs for 1973 to 1990. For 1970 to 1972, we assume annual expenditures equal expenditures in 1973. While expenditures in 1973 were the lowest of any year, expenditures in real dollars remained fairly steady over this time period ($41.3B in 1973 versus an average of $47.2B per year for 1973 to 1990).

Recovering annual estimates after 1991 is more challenging. Table 1 assumes that annual estimates for 1991 to 2014 equal the average expenditures from 1973 to 1990. This is a strong assumption, since the Clean Air Act Amendments of 1990 may have increased spending. However, a separate prospective study by USEPA for 1990 to 2020 (USEPA 2011) provide similar estimates of total spending over this time period. For example, our cost estimates for 2000 to 2014 are $708 billion, which is roughly similar to estimates of $877 billion from EPA. We construct an upper range estimate given a few of these sources. First, we use EPA's restrospective estimates until 1988. We then assume a jump in costs due to the CAAA that correspond to an increase we observe in the PACE data through 1994. We then assume constant cost estimates constant for 1995 to 2000. For 2001 to 2014, we assume costs increase by the same level of changes as in USEPA (2011). This procedure requires substantial imputation and interpolation, which is why Table 1 separately reports estimates for years where such imputation is not needed. This yields an upper bound estimate of $2.7 trillion.

Keiser and Shapiro (2019) discuss an additional source of estimates from the Bureau of Economic Analysis for the years 1972 to 1994. These estimates place expenditures on air pollution abatement at $1.1 to $1.6 trillion. Our estimates using the EPA retrospective analysis provide similar estimates over this time period of $1 trillion.

Online Appendix C:
Methodology for Counting References

This appendix describes methods used to construct Table 2 and Appendix Table 1. Categories in these tables are defined as follows:

- "Top 5 economics" includes the American Economic Review (excluding Papers and Proceedings issues); Econometrica; Journal of Political Economy; Quarterly Journal of Economics; and Review of Economic Studies.
- "Environmental/energy economics" includes Climate Change Economics; Economics of Energy & Environmental Policy; The Energy Journal; Environment and Development Economics; the Journal of Energy and Development; the Journal of the Association of Environmental and Resource Economists; Land Economics; and Marine Resource Economics.
- "Agricultural economics" includes the American Journal of Agricultural Economics; Choices; and the Journal of Agricultural and Resource Economics.
- "Non-economics: environment" includes all journals that JSTOR categorizes into environmental science or environmental studies.
- "Non-economics: health" includes all journals that JSTOR categorizes in health policy, health sciences, or public health, excluding the Journal of the American Water Works Association since it is the only journal in these categories not primary focused on health.
- "NBER Summer Institute" includes Environmental and Energy Economics (EEE) sessions, excluding 5-minute ("egg timer") presentations and excluding mentions of phrases in the bibliography. For papers not linked on NBER's site, we searched to find the closest version of the paper to the NBER conference date. For a few papers we could not find in any form (including under other titles or versions), we guessed the paper's content based on our direct knowledge of the paper or its title.

Journal articles are all from JSTOR and include "all content," limited to "articles" (i.e., excluding reviews, books, reports, pamphlets, or miscellaneous), searched Feb 26-28, 2019. For JSTOR broad categories (economics, environmental, etc.), we click individually on each journal in a category rather than the entire category, since individually selecting each journal lists additional articles.

A few journal classifications are worth explaining. We include the Journal of Agricultural and Resource Economics in "Agricultural Economics" since it emphasizes those topics and is published by the Western Agricultural Economics Association. We include Land Economics in "Environmental/energy economics" although a nontrivial share of its articles address agriculture. We exclude the Journal of the American Water Works Association from "Non-economics: health" since it is the only journal in this category not primarily focused on health. JSTOR also separately lists this journal in "Environmental Science," where we count it. The Journal of Environmental Economics and Management is not indexed in JSTOR, though Kube et al. (2017) review 40 years of its articles and find 52 articles on air pollution and 28 articles on water pollution (they do not distinguish articles on regulation from more general articles on pollution).

Columns 2 and 3 of Table 2 also include articles mentioning "Federal Water Pollution Control Act." In textbooks, for air pollution, we counted page mentions in the index of topics starting with the phrases “CAA or "Clean Air Act." For water pollution, we counted page mentions starting with the phrases “Clean Water Act,” "CWA," "Federal Water Pollution Control Act," or “FWPCA,” “Safe Drinking Water Act,” or “SDWA.” In JSTOR, we did not include the acronyms "CAA," "FWPCA," or "SDWA," since these could represent unrelated phrases.

We obtained lists of National Bureau of Economic Research Summer Institute presentations from the NBER website, and lists of presentations at the Allied Social Science Association meetings from its website. The NBER data cover 2009-2018, while the ASSA data cover years 2011-2019. The ASSA papers include all those in sessions contributed by the Association of Environmental and Resource Economists (AERE). The ASSA data begin in 2011 since earlier years’ AERE sessions are less readily distinguished. When possible, we use versions of these papers from the ASSA and AERE websites. When they are unavailable or links are broken, we use versions of the papers posted on the internet, and prefer paper versions from close to the year of the conference presentation. For cases where these approaches do not find the paper, we guess the content based on our direct knowledge of the paper or on its title.

Appendix Table 1 includes searches for use of the following phrases:

- Air pollution: clean air; air pollution; air quality; air pollutants;
- Surface water pollution: clean water; federal water; water quality; water pollution
- Drinking water pollution: drinking water

These also cover the regulations since, for example, the phrase “clean air” also includes use of the phrase “Clean Air Act.” For NBER and ASSA presentations, we exclude mention of these phrases in the bibliography.

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